The V_{circ}-σ_{c} relation in high and low surface brightness galaxies

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Abstract. We investigate the relation between the asymptotic circular velocity, V_{circ}, and the central stellar velocity dispersion, σ_{c}, in galaxies. We consider a new sample of high surface brightness spiral galaxies (HSB), low surface brightness spiral galaxies (LSB), and elliptical galaxies with HI-based V_{circ} measurements. We find that:
1) elliptical galaxies with HI measurements fit well within the relation;
2) a linear law can reproduce the data as well as a power law (used in previous works) even for galaxies with $\sigma_{\mathrm{c}} < 70$ km/s;
3) LSB galaxies, considered for the first time with this respect, seem to behave differently, showing either larger V_{circ} values or smaller σ_{c} values.

Recently a tight correlation between the bulge velocity dispersion σ_{c} and the galaxy asymptotic circular velocity V_{circ} has been found for a sample of elliptical and spiral galaxies (Ferrarese 2002). The validity of this relation has been also confirmed by Baes, Buyle, Hau, & Dejonghe (2003), who enlarged the spiral galaxy sample. The fact that such a tight relation exists between two velocity scales that probe very different spatial regions (the bulge and the dark matter halo), is a strong indication of a fundamental correlation in the structure not only of spirals but also of ellipticals. On the other hand, it may be interesting to investigate whether the V_{circ}-σ_{c} relation holds also for less dense objects characterized by a shallow potential well in their core. This is the case of LSB galaxies.

We studied the V_{circ}-σ_{c} adding to previous studies data for HSBs, Es, and LSBs. In particular, we consider a sample of 41 HSB spirals (17 from Ferrarese (2002), 7 from Baes et al. 2003, 17 from Pizzella, et al. (2004), 11 LSB spirals Pizzella, et al. (2003), 19 Es from Kronawitter, Saglia, Gerhard, & Bender (2000), which V_{circ} are based on dynamical models. To check whether elliptical galaxies with model-independent V_{circ} values would still follow the same V_{circ}-σ_{c} relation as Spirals, we added 5 Es with HI measurements.

We check that all galaxies have extended rotation curves which are flat in the last region, in order to derive the value of V_{circ}. The resulting V_{circ}-σ_{c} diagram is plotted in Fig. 1a and the conclusions of our work are summarized in the abstract. Here we point out that we have at the moment data for only 11 LSB galaxies. Although a KS test applied to the two distributions shown in Fig.1b, indicates that they are different at a 3σ confidence level and thus that LSBs do not follow the same V_{circ}-σ_{c} relation as HSB and E galaxies, we need more data points for LSB galaxies to confirm such discrepancy.

Confirming this result will highlight yet another aspect in the different formation history of LSBs. Indeed, LSBs appear to have a central potential well less deep than HSB spirals of the same halo mass. If the collapse of baryonic matter cause a compression of the dark halo as well, for LSB galaxies such process may have been less relevant than for
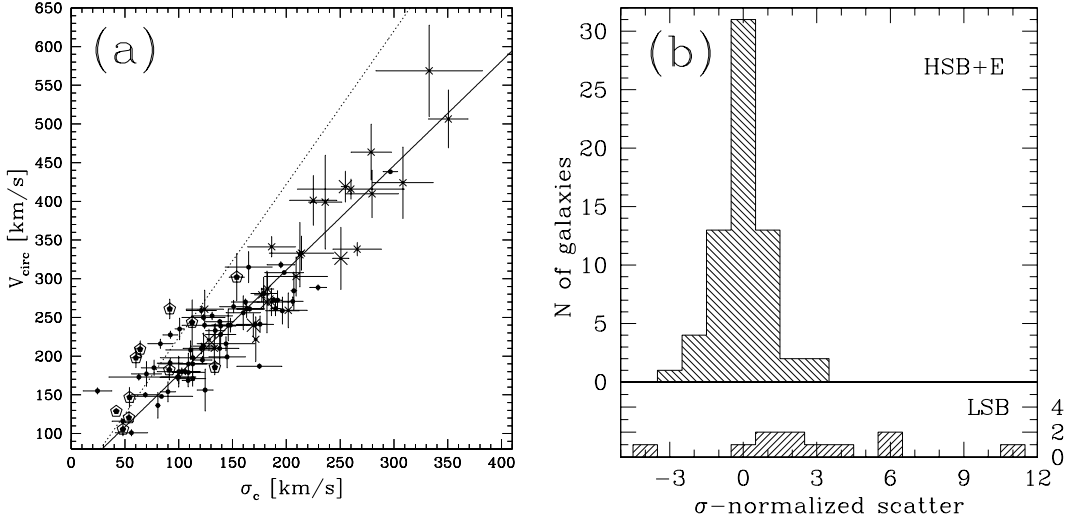
Figure 1. (a): V_{circ}-σ_c relation for galaxies, including ellipticals from Kronawitter et al. (*crosses*) or with HI measurements (*big crosses*), HSBs (*dots*), and LSBs (*dotted pentagons*). The *Full line* represents the linear regression fit of the HSB+E sample. The *dotted line* is the fit on the LSB sample. **(b)**: distribution of the scatter of the data-points with respect to the HSB+E V_{circ}-σ_c relation (*Full line* of Fig. 1a). The scatter accounts for the error bar of each data point. In the *upper panel* we plot the histogram relative to the HSB+E sample and in the *lower panel* the histogram relative to the LSB sample. A KS test indicates that the two distributions are different at a confidence level higher than 3σ.

HSBs. Again LSBs turn out to be the best tracers of the original density profile of dark matter halos and therefore in pursuing the nature of dark matter itself.

References

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